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MEDIAN FILTRATION FOR TESTER PROBE SIGNALS NOISE REDUCING

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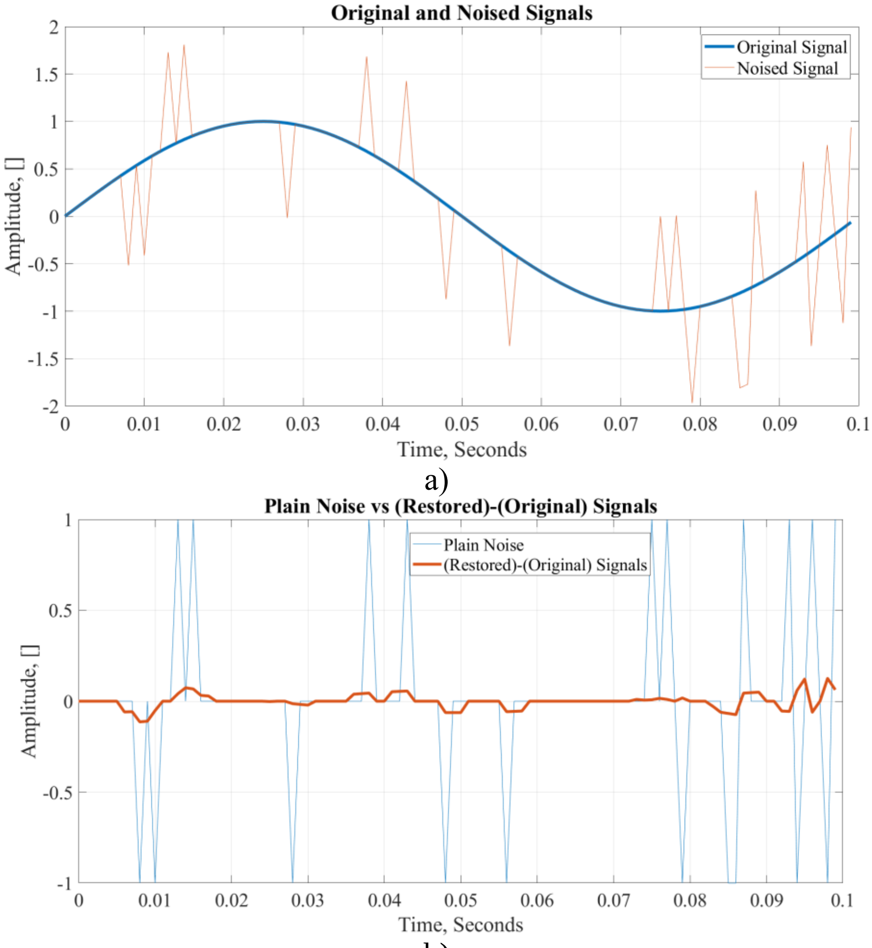
Tester probes are widely used in various scientific and engineering applications to collect data and monitor system performance. However, the signals captured by these probes are often corrupted by noise, which can significantly impact the accuracy and reliability of the measurements. One particularly challenging type of noise is salt-and-pepper noise, which manifests as randomly occurring spikes or dropouts in the signal. This noise can be particularly problematic in applications where precise measurements are critical, such as in semiconductor testing. To address this issue, researchers have explored various signal processing techniques to reduce the impact of salt-and-pepper noise on tester probe signals. One promising approach is the use of median filtration, a nonlinear filtering method that can effectively remove this type of noise while preserving the underlying signal characteristics. In this article, we present a comprehensive analysis of the use of median filtration for reducing salt-and-pepper noise in tester probe signals, and compare its performance for few most commonly-used window sizes.

The median filter is a nonlinear signal processing technique that operates by replacing each data point in a signal with the median value of its neighboring data points. Mathematically, the median filter can be expressed as:y[n] = median(x[n-k], ..., x[n], ..., x[n+k]) where `x[n]` is the input signal, `y[n]` is the filtered output, and `2k+1` is the size of the filtering window.The median filter works by sorting the values within the filtering window and selecting the middle value as the output. This approach is particularly effective at reducing the impact of salt-and-pepper noise, as the median value is not as heavily influenced by the presence of outliers as the mean value used in the simple moving average filter. To illustrate the benefits of median filtration over simple moving average (SMA) for reducing salt-and-pepper noise in tester probe signals, let's consider the following example: Suppose we have a tester probe signal `x[n]` that is corrupted by salt-and-pepper noise, such that:x[n] = s[n] + n[n] where `s[n]` is the true underlying signal and `n[n]` is the salt-and-pepper noise component. We can apply both median filtration and simple moving average to the input signal `x[n]` to obtain the filtered outputs `y_median[n]` and `y_sma[n]`, respectively: y_median[n] = median(x[n-k], ..., x[n], ..., x[n+k]) y_sma[n] = (x[n-k] + ... + x[n] + ... + x[n+k]) / (2k+1). Comparing the two approaches, we can see that the median filter is more effective at preserving the true signal characteristics while removing the salt-and-pepper noise. This is because the median value is less sensitive to the presence of outliers, which are a hallmark of salt-and-pepper noise. In contrast, the simple moving average filter is more vulnerable to the impact of these outliers, as they can significantly skew the calculated mean value. This can lead to a distortion of the underlying signal and a loss of important signal features.



a)

b)

Figure 1 - Original and SaP Noised Signals (a) and Plain Noise vs (Restored)-(Original) Signals (b)

	Median Filter Window Length		
	Window Length = 3	Window Length = 5	Window Length = 7
Root mean square error between Original and SaP Noised Signals	0.447	0.447	0.447
Root mean square error between Original and Restored Signals	0.219	0.039	0.042
Quality Metric: 1-(Root mean square error Ratio)	**0.510**	**0.912**	**0.906**
Coefficient of Determination (R^2) between Original and SaP Noised Signals	0.706	0.706	0.706
Coefficient of Determination (R^2) between Original and Restored Signals	0.885	0.989	0.988
Quality Metric: R^2's difference	**0.180**	**0.284**	**0.282**

Following a comprehensive investigation, it is evident that the median filter, particularly with a window size of 5, stands out as a remarkably effective tool for noise reduction and signal restoration. Its inherent simplicity, computational efficiency, robustness to outliers, and remarkable versatility make it an invaluable asset in a diverse range of signal processing applications.